

**Multi-Purpose Refractory Material**  
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Date of Deposit**Multi-Purpose Refractory Material**

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Relation to other Applications

The present invention is a continuation-in-part of, and claims priority of U.S. Patent Application No. 10/338,425 filed in January of 2003 which is a divisional of U.S. Patent Application No. 09/602,067, filed June 22, 2000 now U.S. Patent No. 6,533, 821, all of which are incorporated by reference in their entirety.

Field of Invention

The present invention relates to a multi-purpose refractory material. More specifically, the invention relates to a phosphate based refractory material for use in a variety of applications including but not limited to: casting and spraying oven parts, panels, blocks and tiles, bonding parts together, and filling in voids in finished castables. The present invention can also be used as a dental cement suitable for casting impressions and as a refractory mold for teeth, bridges and partials. Finally, the invention can be used as a fireproofing material for structural members of buildings.

Background of Invention

Refractories are heat resistant materials that are used for a variety of high-temperature applications including: linings for furnaces, ovens and other reactors, high-

temp panels and blocks, bonding parts together and filling in voids. In addition to being heat resistant (usually above 1000°F), refractory materials must be able to hold up against physical and chemical corrosion.

Most refractory materials are specialized for specific applications within the refractory industry. For example most refractory compositions are used solely as castables or sprayables, few have the ability to be used as both. The present invention is multi-purpose refractory material that exhibits superior compression strength, increased ease of use, quick turn around time.

#### Summary of Invention

An object of the present invention is to provide a multi-purpose refractory and method for producing the same that overcome many of the disadvantages of the prior art.

Another object of the present invention is to provide a multi-purpose refractory. An advantage of the present invention is that it can be used as both as a castable and sprayable.

Yet another object of the present invention is to provide a multi-purpose refractory that provides quick turnaround time. An advantage of the present invention is its fast setting time and rapid strength gain. One embodiment of the present invention has setting time of 90 minutes or less. Another salient feature of the present invention is the refractory's quick demolding time. Yet another advantage of the present invention is its ease of use as only water is needed to activate the dry composition.

Another object of the present invention is to provide a refractory that provides fine detail as a castable. An advantage of the present invention is its superior bonding ability without the use of bonding agents.

Another objection of the present invention is to provide a castable refractory with high compressive strengths. An advantage of the present invention is its high initial

compressive strengths. Certain embodiments of the present invention have compressive strengths of ~3,000psi at 3 hours, ~7,500psi at 3 days, and ~8,500psi after 7 days. The present invention's high green strength allows reduction of casting thickness which reduces cost.

Yet another object of the present invention is to provide a refractory material that can be used as a fireproofing material for structural members of buildings. Advantages of the present invention are its superior bonding properties, high compressive strengths, and ability to withstand temperatures in excess of 2,000°F for prolonged periods of time.

The present invention relates to a multi-purpose refractory material. The present material is moldable and castable and thus ideal for a variety of refractory applications including but not limited to: casting oven parts, panels, blocks and tiles, bonding parts together, and filling in voids in finished castables.

#### Detailed Description of the Invention

The present invention is a moldable and castable material, thereby making it ideal as a refractory. The refractory formulation is comprised of an alkali metal or alkali earth metal phosphate, a metal oxide (or hydroxide), and tricalcium phosphate, preferably an alkali earth metal phosphate.

#### Preferred Embodiment

One exemplary refractory formulation is comprised of potassium phosphate, magnesium oxide and tricalcium phosphate. The amount of each component present in the refractory composition can vary but generally fall within the following weight percent ranges:

Potassium phosphate-an acceptable range is between 25-75 weight percent, preferably between 40-65 weight percent.

Magnesium oxide-an acceptable range is between 15-55 weight percent, preferably between 24-45 weight percent.

Tricalcium phosphate-an acceptable range is between 0.5-25 weight percent, preferably between 3-15 weight percent.

The refractory formulation can be adapted to prevent molten metal from sticking to it with the addition of microsilicas. A suitable microsilica is calcium silicate, in particle sizes ranging from approximately 10 microns to 40 microns.

Exemplary formulations of the refractory binder include the following:

Formulation I\*

Potassium phosphate (technical grade-30 microns)	61 percent
Magnesium Oxide (technical grade-30 microns)	31 percent
Tricalcium Phosphate	8 percent

\* all percentages are percent by weight

Water is added up to 30 weight percent.

The composition of Formulation I can be combined with a filler so that the ultimate mixture contains between 8 and 25 percent weight of the formulation and 75 to 92 percent by weight of the filler. The variation of binder percentage depends on desired consistency and use of the ultimate mixture.

Formulation II\*

Potassium phosphate (technical grade-30 microns)	61 percent
Magnesium Oxide (technical grade-30 microns)	31 percent
Tricalcium Phosphate	8 percent

\* all percentages are percent by weight

Water is added up to 30 weight percent.

In Formulation II,  $\text{CaSiO}_3$  is added to reduce build-up of slag when the binder is used in castable formulations. The silicate addition also reduces build-up in refractories which come in contact with molten metals.

Formulation III\*

Potassium phosphate	45 percent
Magnesium phosphate	45 percent
Tricalcium phosphate	10 percent

\* all percentages are percent by weight

Water is added up to 30 weight percent.

Formulation III is suitable for casting refractory oven parts, panels, blocks and tiles. In such applications, the binder is usually present at between 80-90 weight percent, with the remainder being filler.

#### Formulation IV\*

Potassium phosphate	41 percent
Magnesium oxide	41 percent
Tricalcium phosphate	4.5 percent
Calcium silicate	4.5 percent

\* all percentages are percent by weight

Water is added up to 30 weight percent.

Formulation IV is a multi-purpose refractory grade ceramic cement which can also be used for bonding formed parts together, filling voids in finished castable, and *in vivo* repair of fractures.

#### Formulation V\*

Potassium phosphate	41 percent
Magnesium oxide	41 percent
Tricalcium phosphate	4.5 percent
Silicon dioxide	4.5 percent

\* all percentages are percent by weight

Water is added up to 30 weight percent.

Formulation V is a dental cement suitable for casting of impression and as a refractory mold for teeth, bridges and partials.

Some of the formulations disclosed herein incorporate fillers. Exemplary fillers include, but are not limited to: mullite, alumina, sand, clay, volcanic glasses, kyanite, bauxite, aluminum oxide, silicon dioxide, chrome oxide, iron oxide, and mixtures thereof.

Aside, from MgO (preferred), a myriad of other oxide and hydroxide powders can be utilized, including but not limited to FeO, Al(OH)<sub>3</sub>, FeO<sub>3</sub>, Fe<sub>2</sub>O<sub>4</sub> and Zr(OH)<sub>4</sub>.

#### Dry Composition Preparation

The materials preparation portion of the bio-adhesive formulations disclosed in the original application (U.S. Application No. 09/602,067 filed June 20, 2000, now U.S. Patent No. 6,533,821 issued to Lally on Mar. 18, 2003) is incorporated herein in its entirety, components of the refractory mixture can be dry-mixed and homogenized via a myriad of devices.

A metal oxide (or hydroxide) is a salient feature of the present invention. Optionally, the oxide can be calcined. Calcination temperatures and durations are determined empirically, depending on the final characteristics and setting times desired. Generally, however, calcinations temperatures of up to 1300°C for up to several hours are typical. Generally, pharmaceutical grade oxides (hydroxides) are utilized.

The alkali metal phosphate is preferably mono potassium phosphate.

#### Slurry Preparation

The material is shipped dry to the ultimate situs of usage and is then applied as a slurry once water is added. The amount of water added depends on the workability desired but can be added up to 30% by weight. The slurry is then mixed by a hand, hand mixer or the mixing device to obtain a homogenized slurry. Mixing times and rates will vary depending on slurry composition, desired consistency and other characteristics. When used as a castable it may be advantageous to vibrate the slurry during setting to

remove any air bubbles trapped within the mixture. Generally, and unless additional heat is applied, the exothermic reaction resulting from refractory, with or without the addition of micro-silicates, results in a final green strength of approximately 8500 psi.

Having described the basic concept of the invention, it will be apparent to those skilled in the art that the foregoing detailed disclosure is intended to be presented by way of example only, and is not limiting. Various alterations, improvements, and modifications are intended to be suggested and are within the scope and spirit of the present invention. Additionally, the recited order of the elements or sequences, or the use of numbers, letters or other designations therefore, is not intended to limit the claimed processes to any order except as may be specified in the claims. Accordingly, the invention is limited only by the following claims and equivalents thereto.

. All publications and patent documents cited in this application are incorporated by reference in their entirety for all purposes to the same extent as if each individual publication or patent document were so individually denoted.

#### CLAIMS

I claim the following: